

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions and listings of the claims in the above-captioned patent application.

Listing of Claims:

1. (Currently Amended) A solid state image pickup device comprising:
 - a semiconductor substrate having a first layer of a first conductivity type;
 - a second layer of a second conductivity type opposite to the first conductivity type, said second ~~conductivity type~~ layer being formed on the first conductivity type layer of said semiconductor substrate;
 - a first region of the first conductivity type formed in said second ~~conductivity type~~ layer and constituting a photodiode with said second ~~conductivity type~~ layer;
 - a first gate structure including a charge storage region and a control gate, said first gate structure being formed on a surface of said semiconductor substrate adjacent to a portion of said first region, and said charge storage region being electrically isolated from said first region;
 - a second region of the first conductivity type formed adjacent to said first gate structure on a side opposite to said first region, and constituting a non-volatile memory element with said first region and said first gate structure;
 - an optical window formed on said first region and made of transparent material;
- and

a control circuit for applying a first write voltage to the control gate of said first gate structure, the first write voltage being a write voltage for tunneling and injecting charges accumulated in said first region into the charge storage region.

2. (Original) The solid state image pickup device according to claim 1, wherein said control circuit applies a second write voltage to the control gate of said first gate structure and to the second region after the first write voltage is applied, the second write voltage being a write voltage for injecting charges accumulated in said first region into the charge storage region as hot carrier injection.

3. (Original) The solid state image pickup device according to claim 1, further comprising:

a second gate structure of an insulated gate type formed adjacent to another portion of said first region; and

a third region of the first conductivity type formed adjacent to a side of said second gate structure opposite to said first region, said third region constituting an insulated gate type transistor with said first region and said second gate structure.

4. (Currently Amended) The solid state image pickup device according to claim 1, further comprising a third region of the first conductivity type projecting from an upper surface of the first conductivity type layer of said semiconductor substrate said first layer into said second conductivity type layer.

5. (Original) The solid state image pickup device according to claim 1, wherein the charge storage region of the non-volatile memory element has a floating gate.

6. (Original) The solid state image pickup device according to claim 1, wherein the charge storage region of the non-volatile memory element has an interface between a silicon nitride film and a silicon oxide film.

7. (Currently Amended) A solid state image pickup device comprising:
a semiconductor substrate having a first layer of a first conductivity type;
a second layer of a second conductivity type opposite to the first conductivity type, said second ~~conductivity type~~ layer being formed on the first ~~conductivity type~~ layer of said semiconductor substrate;
a first region of the first conductivity type formed in said second ~~conductivity type~~ layer and constituting a photodiode with said second ~~conductivity type~~ layer;
a first gate structure including a charge storage region and a control gate, said first gate structure being formed on a surface of said semiconductor substrate adjacent to a portion of said first region, and said charge storage region being electrically isolated from said first region;
a second region of the first conductivity type constituting a non-volatile memory element with said first region and said first gate structure, formed adjacent to said first gate structure on a side opposite to said first region ;
an optical window formed on said first region and made of transparent material;

a second gate structure of an insulated gate type formed adjacent to another portion of said first region; and

a third region of the first conductivity type formed adjacent to said second gate structure on a side opposite to said first region, said third region constituting an insulated gate type transistor with said first region and said second gate structure.

8. (Original) The solid state image pickup device according to claim 7, further comprising a control circuit for applying a bias voltage to said second gate structure to turn on the insulated gate type transistor and supplying current to the non-volatile memory element.

9. (Original) The solid state image pickup device according to claim 7, wherein the charge storage region of the non-volatile memory element has a floating gate.

10. (Original) The solid state image pickup device according to claim 7, wherein the charge storage region of the non-volatile memory element has an interface between a silicon nitride film and a silicon oxide film.

11. (Currently Amended) A solid state image pickup device comprising:
a semiconductor substrate having a first layer of a first conductivity type;
a second layer of a second conductivity type opposite to the first conductivity type, said second conductivity type layer being formed on the first ~~conductivity type~~ layer of said semiconductor substrate;

a first region of the first conductivity type formed in said second ~~conductivity type~~ layer and constituting a photodiode with said second ~~conductivity type~~ layer;

a first gate structure including a charge storage region and a control gate, said first gate structure being formed on a surface of said semiconductor substrate adjacent to a portion of said first region, and said charge storage region being electrically isolated from said first region;

a second region of the first conductivity type formed adjacent to said first gate structure on a side opposite to said first region, and constituting a non-volatile memory element with said first region and said first gate structure;

an optical window formed on said first region and made of transparent material;
and

a control circuit for applying a forward bias voltage to the first ~~conductive type~~ layer of said semiconductor substrate to supply current to the non-volatile memory element.

12. (Currently Amended) The solid state image pickup device according to claim 11, further comprising a third region of the first conductivity type projecting from an upper surface of the first ~~conductivity type layer of said semiconductor substrate~~ said first layer into said second conductivity type layer.

13. (Original) The solid state image pickup device according to claim 11, wherein the charge storage region of the non-volatile memory element has a floating gate.

14. (Original) The solid state image pickup device according to claim 11, wherein the charge storage region of the non-volatile memory element has an interface between a silicon nitride film and a silicon oxide film.

15. (Currently Amended) A driving method for a solid state image pickup device, comprising the steps of:

(a) applying light to photodiodes distributed in a matrix layout and accumulating charges representative of image information, said photodiodes being formed in a ~~second conductivity type layer formed on a first conductivity type layer of a semiconductor substrate, the first conductivity type being opposite to the second conductivity type~~ second layer having a second conductivity type and being formed on a first layer of a semiconductor substrate, said first layer having a first conductivity type opposite to said second conductivity type, said solid state image pickup device having optical windows made of transparent material and formed respectively on said photodiodes;

(b) applying a first write control voltage to a control gate of a non-volatile memory element having a charge storage region, the control gate and a drain region, the non-volatile memory element being formed adjacent to each of the photodiodes, each of said charge storage regions being electrically isolated from associated one of said photodiodes, and tunneling and injecting at least a portion of the charges representative of the image information into the charge storage region as signal charges; and

(c) applying a read control voltage to the non-volatile memory element to detect a threshold voltage corresponding to an amount of the signal charges injected at said step (b) into the charge storage region.

16. (Original) The driving method for a solid state image pickup device according to claim 15, further comprising a step of, before said step (c):

(d) applying a second write control voltage to the control gate and drain region of the non-volatile memory element and injecting as hot carriers at least a portion of the charges representative of the image information into the charge storage region as signal charges.

17. (Original) The driving method for a solid state image pickup device according to claim 15, wherein said step (c) includes a sub-step of:

(e) applying a bias voltage to an insulated gate type transistor formed adjacent to another portion of each of the photodiodes to turn on the transistor and supply a channel current to the non-volatile memory element.

18. (Currently Amended) The driving method for a solid state image pickup device according to claim 15, wherein said step (c) includes a sub-step of:

(f) applying a forward bias voltage to the first ~~conductivity-type~~ layer of the semiconductor substrate to supply a channel current to the non-volatile memory element.

19. (Currently Amended) The driving method for a solid state image pickup device according to claim 15, wherein said step (c) includes a sub-step of:

(g) applying a forward bias voltage to a first region of the first conductivity type formed projecting from an upper surface of the first ~~conductivity-type~~ layer of the semiconductor substrate into the second ~~conductivity-type~~ layer to supply a channel current to the non-volatile memory element.

20. (Original) The driving method for a solid state image pickup device according to claim 15, further comprising a step of, before said step (a):

(h) applying a reverse bias voltage to the first conductivity type layer of the semiconductor substrate to drain charges accumulated beforehand in the photodiodes to a semiconductor substrate side.